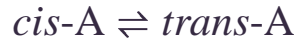


Chemistry 342
Fall, 2001
Final Exam

Answer all eight questions. Please leave the front page of your answer book blank, apart from your name.

1. (20 points) The enthalpy of combustion of buckminsterfullerene, C_{60} , is -2.589×10^4 kJ/mol. What is the enthalpy of formation of C_{60} ? (Note that the enthalpy of formation of gaseous CO_2 is -393.51 kJ/mol.)
2. (25 points) While Bob and Alice are busy heating their apartments with their stove and refrigerator, Carol has a much better idea. She installs a solar heating unit on the roof of her building and uses sunlight to heat her apartment. Her apartment has a volume of 600 m^3 . Treat the air as a perfect diatomic gas and ignore the heat capacity of the walls, floors, and ceilings. The area of the solar panels that collect the sunlight is 10 m^2 , and the flux of solar energy (also known as the solar constant) is 0.1353 W/cm^2 . How long does it take Carol to heat her apartment from 20 to 25°C ?
3. (25 points) The partial molar volumes of ethanol and water in a 50% (mole fraction) mixture are, respectively, 57 and $17 \text{ cm}^3/\text{mol}$. Suppose that 1.0 cm^3 of pure ethanol is added to 1.000 liter of a 50% mixture. What is the volume of the resulting solution? (The density of pure ethanol is 0.789 g/cm^3 and its molecular weight is 46.07 g/mol .)

4. (25 points) Consider the following gas phase isomerization reaction of compound A:



A. Suppose that $\Delta G_r^0 = 3\text{kJ/mol}$ at 298 K. What is the equilibrium constant at this temperature?

B. Suppose that 1 atm of pure *cis*-A is prepared at 298 K. Calculate the mole fractions of both isomers at equilibrium.

C. Suppose that 2 atm of pure *cis*-A is prepared at 298 K. Calculate the mole fractions of both isomers at equilibrium and show that your result is consistent with Le Chatlier's principle.

5. (20 points) In the previous problem, suppose that $\Delta S_r^0 = 5\text{J/mol/deg}$ at 298 K. Calculate the equilibrium constant at 350K and show that your result is consistent with Le Chatlier's principle.

6. (30 points) The velocity distribution of a certain set of particles is given by

$$\begin{aligned} f(v) &= 0 & v < 0 \\ &= C(9v - v^2) & 0 \leq v \leq 9 \text{ m/s} \\ &= 0 & v > 9 \text{ m/s} \end{aligned}$$

where C is a constant.

- A. Evaluate C.
- B. Calculate the most probable value of v.
- C. Calculate the mean value of v.
- D. Calculate the root mean square value of v.

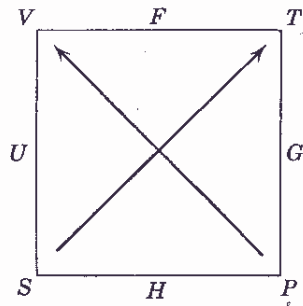
7. (25 points) Use some of the information given below to answer the following questions.

A. A piece of lead has a volume of 1 cubic meter at 298 K and 1 atm. What is its entropy?

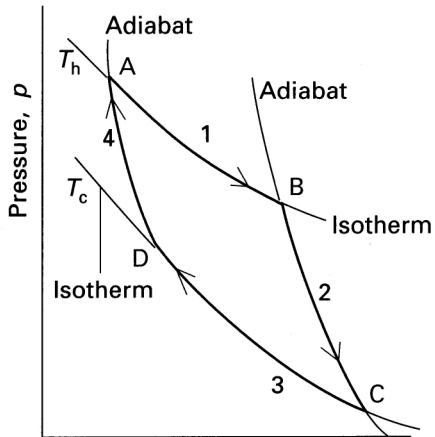
B. Suppose the temperature is increased to 400 K at a pressure of 1 atm. What is the entropy of the lead?

C. Suppose the pressure is increased to 10^4 atm at 298 K. What is the entropy of the lead?

Atomic weight	Density	$C_{P,m}^0$	S_m^0	α	κ_T
g/mol	g/cm ³	J/mol/K	J/mol/K	K ⁻¹	atm ⁻¹
207.19	11.350	26.44	64.81	8.61×10^{-5}	2.21×10^{-6}



8. (30 points) This problem deals with the changes in Gibbs free energy of an ideal gas in a Carnot cycle. Please label your states using the notation in the following diagram.



A. What is the change in Gibbs free energy for *each* of the four parts of the Carnot cycle?

B. Add up the values of ΔG in the previous question and prove that their sum is zero.